REMARKS

Applicant respectfully requests further examination and reconsideration in view of the above amendments and arguments set forth fully below. Claims 1-14 and 18-26 were previously pending in this instant application. Within the Office Action, Claims 1-14 and 18-26 have been rejected. By the above amendments, Claims 10 and 26 have been amended. Accordingly, Claims 1-14 and 18-26 are now pending in this application.

Rejections Under 35 U.S.C. § 103(a)

Within the Office Action, Claims 1-14 and 18-26 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over the Japanese Publication No. 05-097583-A to Shinya (hereafter "Shinya"), in view of U.S. Patent No. 5,236,545 to Pryor (hereafter "Pryor ") and either U.S. Patent No. 5,451,260 to Versteeg et al. (hereafter "Versteeg") or U.S. Patent No. 5,874,014 to Robson et al. (hereafter "Robson"). The Applicant respectfully disagrees with these rejections for the following reasons. As explained in detail below, the combination of Shinya, Pryor, Versteeg and Robson is improper. Further, neither Shinya, Pryor, Versteeg, Robson nor their combination teach supplying the liquid precursor into the reaction chamber without interrupting formation of the diamond. Neither Shinya, Pryor, Versteeg, Robson nor their combination teach a liquid precursor substantially free of water. Furthermore, neither Shinya, Pryor, Versteeg, Robson nor their combination teach forming diamond without seeding.

Diamond growth is a function of plasma density, reaction chamber pressure, carbon-to-oxygen ratio at the substrate surface, and precursor flow rate. The present invention provides a system for controlling all of these variables to promote rapid, substantially uniform and reproducible diamond growth. In accordance with the embodiments of the invention, the liquid precursor is continually supplied during the process without interruption. A dopant can be readily added to the liquid precursor, thus incorporating the dopant into the diamond structure formed. The method of the present invention allows diamond crystallites to be grown without seeding, provides a significant cost reduction over prior art methods and eliminates the need to use explosive gas mixtures or toxic precursors. As described below, there are several claimed features which provide the aforementioned advantages, which are neither taught nor suggested in the prior art.

The present invention is directed to a method of synthesizing diamond utilizing plasma-enhanced chemical vapor deposition (CVD) using a "non-magnetic-field microwave plasma system." The present invention uses liquid precursors that are substantially free of water and that are formed from a mixture of methanol and at least one carbon and oxygen containing compound, such as ethanol, isopropanol, acetone or a mixture thereof. The carbon and oxygen containing compound has a carbon to oxygen ratio that is greater than one. The diamond growth process of the present invention is preferably carried out at relatively high pressures, such as in a range of 70 to 130 or 10 to 130 Torr. These and other distinguishing features are recited in each of the independent Claims 1, 10 and 26.

Shinya discloses eliminating the need for hydrogen, due to its highly explosive nature, for the purpose of increasing safety in the plasma-enhanced chemical vapor deposition (CVD) of diamond. Instead of using hydrogen, Shinya incorporates an OH group-containing alcohol as the reaction gas. This reaction gas is used as feedstock to synthesize a diamond film without further diluting the gas with hydrogen. Shinya fails to disclose several features of the present invention. The first of these is the addition of at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one to the precursor composition. Pryor is cited within the Office Action in combination with Shinya to attempt to render this feature of the present invention as obvious. Additionally, Shinya fails to teach or suggest a liquid precursor that is in liquid form upon introduction into the reaction chamber and subsequently vaporized. It is stated within the Office Action that either Versteeg or Robson, in combination with Shinya render this second feature of the present invention as obvious. Shinya also does not disclose the pressure range of about 70 to 130 Torr or the ability to utilize a seedless substrate.

Applicant respectfully submits that there is no teaching nor expectation for success concerning the combination of Shinya with Pryor. The purpose of Shinya is to create a safer method of forming a diamond film, not the optimization of diamond film production. Shinya illustrates this purpose by teaching a safer method of forming diamond films without the need for the highly explosive gas hydrogen. [Shinya, Abstract] Shinya does not teach that diamond film formation without the use of hydrogen is the optimal method of diamond film production. Shinya only teaches that diamond film formation without hydrogen is a safer method of diamond film production. Contrarily, the purpose of Pryor is to optimize diamond film production, not to increase the safety of diamond film production. Pryor illustrates this by teaching a method for

preparing diamond films on silicon substrates utilizing 90 to 99 volume percent hydrogen, a very dangerous and explosive gas. [Pryor, col. 9, lines 23-24] As a result of these two conflicting purposes, there is no teaching within either reference that would suggest their compatibility.

Previously, Applicant argued that all of Pryor's solutions contain hydrogen, the very reactive gas that Shinya's invention is aimed at eliminating. It is stated within the Office Action that "there is a reasonable expectation of success that the precursor mixtures of Pryor will achieve the result in Shinya without hydrogen, as Shinya teaches that one may eliminate hydrogen from the reaction mixture by using alcohols as a reactant gas." Success in using Pryor's compositions for feedstock with Shinya's invention is unlikely to occur for several reasons. The first of these reasons is the fact that all of Pryor's compositions contain hydrogen, the very gas which Shinya is aimed at eliminating. Furthermore, Shinya does not just avoid the use of hydrogen - increasing safety by eliminating the need for hydrogen is a primary goal of Shinya. The Abstract of Shinya's application begins with the purpose of eliminating the need for hydrogen. "PURPOSE: To eliminate the need for hydrogen ... to increase safety ..." [Shinya, Abstract, emphasis added] If Pryor's compositions were removed from his invention and placed in Shinya's, this new combination would not work, as a diamond deposition process geared to operate in the absence of hydrogen would not operate successfully if the explosive gas were present. Pryor's compositions will not work in Shinya's diamond deposition method. Because there is no expectation of success, Shinya and Pryor would not have been combined by a person having ordinary skill in the art at the time of the invention.

It is argued within the Office Action that "in light of the teachings of Shinya, it would be obvious to a person having ordinary skill in the art to remove the hydrogen from Pryor's composition and arrive at a successful composition for use in the deposition of diamond that is substantially similar to that used in the present invention." This argument fails to show either that there existed a reason to perform the chemical modifications necessary to achieve the claimed invention or that the combination would achieve success. Besides, Pryor's compositions do not merely contain hydrogen, but Pryor teaches that "it is preferred that the feedstock gas mixture comprise from about 90 to 99 volume percent hydrogen." [Pryor, col. 9, lines 23-24] This overabundance of hydrogen would provide for a huge void in the composition if it were to be removed. The discrepancies between a composition of 100% alcohols (Shinya) and a composition of 99% hydrogen (Pryor) are too great to assume that the other 1% of Pryor's

composition can be applied successfully to Shinya's entire precursor. Applicant respectfully submits that to take the composition of Pryor and implement it into Shinya's method would involve the removal of 90-99 percent of the original composition. Replacing such a void and determining which composition of alcohols or other substances to use for such a replacement would not be obvious to a person having ordinary skill in the art.

Further, the nature of Pryor's invention renders his use of carbon-containing precursors such as methanol or ethanol, to be in a completely different environment than that of Shinya's. Shinya's invention deposits diamond films on a substrate in a reaction chamber. Pryor implements not only a substrate - limited to being comprised of silicon - within a reaction chamber, but also requires the deposition of two additional layers as well. These two layers comprise an epitaxial cubic boron nitride layer and an ultra-thin, laser ablated diamond precursor carbon layer. Pryor explains the role of the layers when he states "the first interfacial layer provides a lattice-matching layer between the diamond and silicon layers...the second interfacial layer appears to prevent the volatilization of the cubric boron nitride layer in the presence of methyl radicals or other reactive species formed during the CVD process." [Pryor col. 3, lines 44-61] Furthermore, Pryor's deposition method requires "a combination of laser ablation and microwave CVD techniques." [Pryor, col. 3, lines 37-38] All of these factors establish the methods and conditions through which Shinya and Pryor accomplish the deposition of diamond to be substantially different. It follows that there is no expectation of success concerning the interchangeability and substitution of certain aspects of Pryor's precursor composition with Shinya's precursor composition.

Thus, despite the fact that Pryor uses carbon-containing precursors such as methanol or ethanol and combinations thereof, these alcohols constitute a minimal percentage of the precursor composition when compared to the presence of hydrogen. They are also implemented in substantially different conditions and through substantially different methods than the deposition process occurring in Shinya's process.

No expectation for success exists regarding the combination of Shinya with Pryor. Thus, no reference or combination of references cited teaches or fairly suggests a feedstock "containing methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one."

Within the MPEP it is stated, "[i]t is improper to combine references where the references teach away from their combination. In re Grasselli, 713 F.2d, 743 (Fed. Cir. 1983); MPEP § 2145 (X)(D)(2). As described in detail above, Shinya's purpose is to increase safety by eliminating hydrogen, but Pryor uses hydrogen, in fact, Pryor includes 90-99% hydrogen. Clearly, according to the MPEP, it is highly improper to combine Shinya and Pryor as they completely teach away from each other.

Moreover, the MPEP also states, "[a] prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention." W.L. Gore & Associates, Inc. v. Garlock, Inc. 721 F.2d 1540 (Fed. Cir. 1983); MPEP § 2141.02 (VI). In light of this requirement of the MPEP, it is clearly improper to combine Shinya with Pryor, as Pryor clearly teaches using hydrogen when Shinya's purpose is to avoid hydrogen.

Furthermore, the MPEP states, "[i]f the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. In re Ratti, 270 F.2d 810, 123 (CCPA 1959); MPEP §2143.01. Considering the proposed combination of Shinya and Pryor involves removing 90-99% of Pryor's original composition, this combination clearly falls within this section of the MPEP, as Pryor's principle of operation is completely changed. Thus, for yet another reason, the combination of Shinya and Pryor is improper.

Even if a combination of Shinya with Versteeg or Robson taught the feedstock entering the chamber as liquid and then being vaporized, such a combination of references fails to render the claims of the present invention as obvious.

Neither Shinya, Pryor, Versteeg, Robson nor their combination teach a liquid precursor substantially free of water. In fact, Shinya teaches the process includes, "little addition of water." [Shinya, Paragraph 11] Therefore, neither Shinya, Pryor, Versteeg, Robson nor their combination teach a liquid precursor substantially free of water.

As mentioned above, Shinya simply discloses a precursor containing methanol or ethanol. No mention is made concerning the addition of the carbon and oxygen containing compound. Pryor lists off a number of combinations for the precursor solution, including a recommendation to include oxygen. However, all of Pryor's solutions contain hydrogen, the very reactive gas the present invention and Shinya's are designed to exclude from the process. The fact that Pryor

includes hydrogen in all of his solutions while Shinya's purpose is to increase safety by eliminating hydrogen shows there is no motivation to combine Shinya with Pryor for any purpose. As described in detail above, even if one were to combine Pryor and Shinya, the presence or absence of hydrogen, a central aspect on which both disagree, renders the combination impractical and unlikely, as well as improper, according to the MPEP.

In light of the arguments against combining Shinya and Pryor, it should also be noted that neither relates the significant benefits of using the present invention's precursor solution - which also proves that no evidence exists leading to a motivation to combine. In Paragraphs 0027-0033 of the present specification, the Applicant discloses multiple benefits of using the solution. In Paragraph 0028, Lines 1-6, of the present specification, it is provided that "When the liquid precursor [is composed of the disclosed methanol-based solution], diamond growth is substantially uniform, reproducible, and at a higher growth rate than with conventional CVD methods." This is due to the unique deposition-aiding radicals that the methanol vapor releases when it disassociates. In Paragraph 0033, Lines 11-15, of the present specification, it is noted that "...diamond crystallites could be grown on aluminum at temperatures below that of the melting point of aluminum...Also, diamond crystallites can be grown without seeding, which is difficult to do using other chemical vapor deposition systems."

With respect to the pressure ranges of 10 to 130 Torr and 70 to 130 Torr, these ranges are indeed novel and more importantly were not obvious prior to this invention due to the fact that they are enabled by the liquid precursor being substantially free of water and containing methanol and at least one carbon and oxygen containing compound having a carbon-to-oxygen ratio greater than one. Since the disclosed liquid precursor is novel and non-obvious, then the pressure ranges it affords are also nonobvious, especially when considering the fact that the ranges are larger and wider than any of the other ranges disclosed in the cited references.

Neither Shinya, Pryor, Versteeg, Robson nor their combination teach supplying the liquid precursor into the reaction chamber without interrupting formation of the diamond. Versteeg is recited as teaching this limitation, specifically, Col. 2, Line 44 through Col. 3, Line 24 of Versteeg. However, there is nothing in the cited section that teaches supplying the liquid precursor into the reaction chamber without interrupting formation of the diamond.

Neither Shinya, Pryor, Versteeg, Robson nor their combination teach a method of forming diamond without seeding. The Applicant respectfully disagrees that "without seeding" is obvious when reading Shinya. There is nothing in Shinya that teaches, hints or suggests forming diamond without seeding. As discussed above, the purpose of Shinya is increased safety by avoiding the use of hydrogen. Without any hint, teaching or suggestion of forming diamond without seeding, a rejection of claims with this limitation using Shinya is improper. Furthermore, the Applicant respectfully disagrees that "without seeding" is not given patentable weight because it is in the preamble. Within the MPEP, it is stated that "[i]f the claim preamble, when read in the context of the entire claim, recites limitations of the claim, or, if the claim preamble is 'necessary to give life, meaning, and vitality' to the claim, then the claim preamble should be construed as if in the balance of the claim." Pitney Bowes, Inc. v. Hewlett-Packard Co., 182 F.3d 1298, 1305 (Fed. Cir. 1999); MPEP § 2111.02. In the present situation, "without seeding" in the preamble gives provides further limitation that the claimed method of forming diamond is done so without seeding and therefore should be given patentable weight. However, even if "without seeding" is not given patentable weight, by the above amendments the limitation of "seedless" has been added to the body of the claim and therefore, a rejection of claims with this limitation using Shinya is improper.

As discussed above, the combination of Shinya with Pryor is improper. For the same reasons, the combination of Shinya, Pryor, Versteeg and Robson is also improper. As also discussed above, neither Shinya, Pryor, Versteeg, Robson nor their combination teach a liquid precursor substantially free of water. As also discussed above, neither Shinya, Pryor, Versteeg, Robson nor their combination teach supplying the liquid precursor into the reaction chamber without interrupting formation of the diamond. Also, neither Shinya, Pryor, Versteeg, Robson nor their combination teach forming diamond without seeding.

The independent Claim 1 is directed to a method of forming diamond. The method of Claim 1 comprises providing a substrate in a reaction chamber in a non-magnetic-field microwave plasma system, providing, in the absence of a gas stream, a liquid precursor substantially free of water and containing methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one, to a metering valve associated with an inlet of the reaction chamber, passing liquid precursor into the reaction chamber inlet with the metering valve wherein the liquid precursor enters the metering valve as

liquid and vaporizes during entry into the reaction chamber inlet to generate vaporized precursor and subjecting the vaporized precursor, in the absence of a carrier gas and in the absence of a reactive gas, to a plasma under conditions effective to disassociate the vaporized precursor and promote diamond growth on the substrate in a pressure range from about 70 to 130 Torr. As discussed above, the combination of Shinya, Pryor, Versteeg and Robson is improper. As also discussed above, neither Shinya, Pryor, Versteeg, Robson nor their combination teach a liquid precursor substantially free of water. For at least these reasons, the independent Claim 1 is allowable over the teachings of Shinya, Pryor, Versteeg, Robson and their combination.

Claims 2-9 are all dependent on the independent Claim 1. As described above, the independent Claim 1 is allowable over the teachings of Shinya, Pryor, Versteeg, Robson and their combination. Accordingly, Claims 2-9 are all also allowable as being dependent on an allowable base claim.

The independent Claim 10 is directed to a method of forming diamond. The method of Claim 10 comprises providing a substrate in a reaction chamber in a non-magnetic-field microwave plasma system, the reaction chamber being in fluidic communication with a container through a metering valve, wherein the container includes a liquid precursor substantially free of water containing methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one, flowing the liquid precursor into the reaction chamber using the metering valve, in the absence of a gas stream flowing through the metering valve entraining the liquid precursor, wherein the liquid precursor enters the metering valve as liquid and vaporizes during entry into the reaction chamber, subjecting the vaporized precursor to a plasma under conditions effective to disassociate the vaporized precursor in the absence of a carrier gas and in the absence of a reactive gas and promoting diamond growth on the substrate at a pressure in the range from about 10 to 130 Torr. As discussed above, the combination of Shinya, Pryor, Versteeg and Robson is improper. As also discussed above, neither Shinya, Pryor, Versteeg, Robson nor their combination teach a liquid precursor substantially free of water. For at least these reasons, the independent Claim 10 is allowable over the teachings of Shinya, Pryor, Versteeg, Robson and their combination.

Claims 11-14 and 18-25 are all dependent on the independent Claim 10. As described above, the independent Claim 10 is allowable over the teachings of Shinya, Pryor, Versteeg, Robson and their combination. Accordingly, Claims 11-14 and 18-25 are all also allowable as being dependent on an allowable base claim.

Furthermore, with respect to Claim 24, neither Shinya, Pryor, Versteeg, Robson nor their combination teach supplying the liquid precursor into the reaction chamber without interrupting formation of the diamond.

The independent Claim 26 is directed to a method of forming diamond without seeding. The method of Claim 26 comprises providing a seedless substrate in a reaction chamber in a non-magnetic-field microwave plasma system, the reaction chamber being in fluidic communication with a container through a metering valve, wherein the container includes a liquid precursor substantially free of water containing methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one, supplying the liquid precursor into the reaction chamber without interrupting formation of the diamond using the metering valve, in the absence of a gas stream flowing through the metering valve entraining the liquid precursor, wherein the liquid precursor enters the metering valve as liquid and vaporizes during entry into the reaction chamber, subjecting the vaporized precursor to a plasma under conditions effective to disassociate the vaporized precursor in the absence of a carrier gas and in the absence of a reactive gas and promoting diamond growth on the substrate at a pressure in the range from about 10 to 130 Torr. As discussed above, the combination of Shinya, Pryor, Versteeg and Robson is improper. As also discussed above, neither Shinya, Pryor, Versteeg, Robson nor their combination teach a liquid precursor substantially free of water. As also discussed above, neither Shinya, Pryor, Versteeg, Robson nor their combination teach supplying the liquid precursor into the reaction chamber without interrupting formation of the diamond. Also, neither Shinya, Pryor, Versteeg, Robson nor their combination teach forming diamond without seeding. For at least these reasons, the independent Claim 26 is allowable over the teachings of Shinya, Pryor, Versteeg, Robson and their combination.

For the reasons given above, Applicant respectfully submits that Claims 1-14 and 18-26 are now in a condition for allowance, and allowance at an early date would be appreciated. Should the Examiner have any questions or comments, the Examiner is encouraged to call the undersigned at (408) 530-9700 to discuss the same so that any outstanding issues can be expeditiously resolved.

Respectfully submitted,
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